Irrigation System in Indian Punjab

Inderjeet Singh and Kesar Singh Bhangoo

Economics Department, Punjabi University, Patiala (Punjab), INDIA, Center for Research in Economic Change, Punjabi University, Patiala (Punjab), INDIA

29. September 2013

ECONOMICS DEPARTMENT
(CENTRE FOR ADVANCED STUDIES)

Irrigation System in Indian Punjab

Inderjeet Singh
Kesar Singh Bhangoo

Sep 2013

PUNJABI UNIVERSITY, PATIALA, INDIA

Irrigation System in Indian Punjab

Inderjeet Singh
Professor, Planning Commission Chair,
Economics Department, Punjabi University, Patiala (Pb), INDIA
inderjeetsidhu@rediffmail.com

Kesar Singh Bhangoo
Professor, Centre for Research in Economic Change,
Economics Department, Punjabi University, Patiala (Pb), INDIA
kesarbhangoo@gmail.com

Abstract

Punjab model of irrigation is characterized by excess demand for water for irrigation, coupled with unconstrained mining of groundwater, for meeting the food bowl requirements of the country. It is a model guided by populist political decisions than a sound economics. In the process, the model has provided the much needed food security to the country but has raised serious ecological and environmental concerns. This is a high time to analyze the irrigation system in its historical perspective and prescribe a policy framework for the future. The paper, covering the evolution of the system, evaluates the performance and delineates the policy options for the future.

Keywords: Irrigation, Canal Water, Water Resources

Introduction

World over the irrigation has acquired an increasing importance in agriculture. From just 8 million hectares (M Ha) in 1800, irrigated area across the world increased fivefold to 40 M Ha (13.4 M Ha in India) in 1900, to 100 M Ha in 1950 and to just over 255 M Ha in 1995; with almost one fifth of that area (50.1 M Ha net irrigated area), India has the highest irrigated land in the world today (Postel, 1999). India's irrigation development in this century, and particularly after independence, has seen number of large storage based systems, all designed and maintained by the government effort and money. In the British period, a few storage structures were built only in the beginning of this century and the post independence India, however, has seen more than 60 percent of irrigation budgets going for major and medium projects (Thakkar, 1999). Large scale irrigation is synonymous with canal irrigation in India and canal irrigation is a costly proposition, more so when provided under the aegis of grave inefficiencies in project implementation and canal operation (Dhawan, 1997). Punjab is a granary state of India and its input-output system is heavily biased in favor of agriculture (Singh and Singh, 2011). Punjab model of irrigation is characterized by excess demand for water for irrigation coupled with unconstrained mining of groundwater for meeting the food bowl requirements of the country. The paper, covering the evolution of the system, evaluates the performance and delineates the policy options for the future.

Background

The state of Punjab has an area of 50362 square kilometers falling between latitude 29°32' – 32°28' and longitude 73°50' – 77°00'. Presently, there are 20 districts and 141 blocks in the state. It is the most developed State of India where all the villages are approachable by metaled roads and are cent-percent electrified. The State is flat alluvial plain except in a thin belt along north eastern border, where it is mountainous and in the South-Western where stable sand dunes are seen dotting the landscape. The climate of the State is semi-humid and semi-arid. The rainfall decreases progressively from 125 cm in Northeast (Dhar Kalan) to about 30 cm in Southwest (Ferozepur). The State has a well-defined rainy period in summer from July to September and a long dry spell further puts a pressure on man-made irrigation systems. The ground water level varies from almost near surface to about 65m below the ground level. The deep water levels are recorded in the Kandi belt and water logging conditions exist in some parts of South-Western districts.

The State of Punjab is a part of the Indus River System in the north and north-west of the Indian Sub-continent. It is separated from the Ganga basin by the Ghaggar River. It flows only seasonally and is famous for its flash floods in the south-eastern parts of the state. Other significant perennial rivers of the Indus system, which flows through Punjab, are Ravi, Beas and Sutlej that together carry 40.5×10^9 m^3 of water. Himalayan glaciers melt account for about 58 percent of the source water supply of these rivers. All these rivers are tapped by using dams at different levels in the catchment areas and stored water is utilized for irrigation through a strong network of canals in the command areas. These rivers feed a vast network of canal system in the State and provide water to the neighboring states, Haryana and Rajasthan.

I
Evolution of Infrastructure and Institutions since 1947

The Indus Basin mainly comprises of the erstwhile Sind and Punjab provinces of India in South Asia and presently this Basin has been divided between India and Pakistan (Map 1). The Sind, Chenab, Jhelum, Ravi, Beas and Sutlej are the major rivers of this basin flowing from Himalayans into Arabian Sea. It is bounded on the north by the Karakoram and Haramosh ranges, on the east by the Himalayas, on the west by the Sulaiman and Kirthar ranges and on the south by the Arabian Sea. The total area of the Indus Basin, 1165500 square kilometers lies in Tibet, Afghanistan, India and Pakistan (CWC, 2011). The Indus basin was divided into two parts between India and Pakistan during partition of India. In 1960, the Indus Water Treaty (Box 1), divided the Indus River Basin and out of total six major rivers of Indus Basin three eastern rivers, i.e., Sind, Chenab and Jhelum were awarded to Pakistan and three western rivers, i.e., Sutlej, Ravi and Beas to India. The division of the Indus basin provided 56 percent area to Pakistan and 31 percent to India. The division of Indus Basin between India and Pakistan had far reaching and long term implications for the residents of the basin.

Map and Box 1: Indus basin river system and treaty

Box 1: Indus Water Treaty

1948: After partition, India stopped the supply of water to Pakistan from every canal flowing from India to Pakistan.

1952: On protest by Pakistan, India agreed on an interim agreement and Pakistan approached the World Bank to settle the problem permanently.

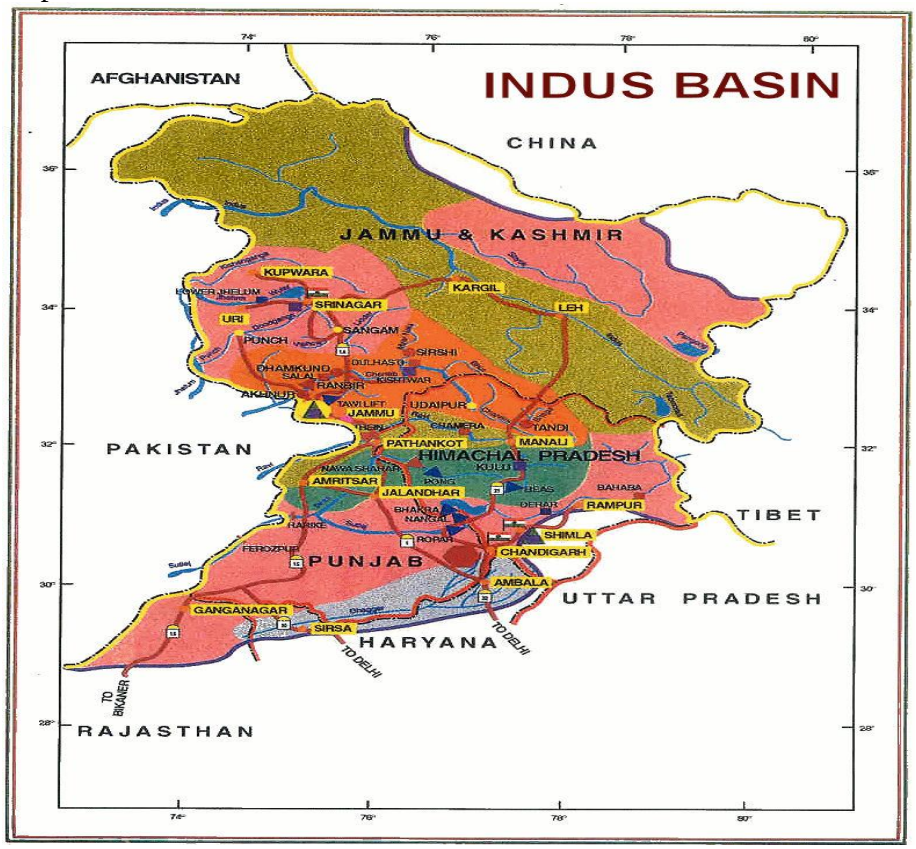
1960: Negotiations were carried out between the two countries through the offices of the World Bank and the Indus Water Treaty (an agreement) was signed between India and Pakistan in September, 1960. This treaty divided the use of rivers and canals between the two countries. Pakistan obtained exclusive rights for the three western rivers, namely Indus, Jehlum and Chenab and India retained rights to the three eastern rivers, namely Ravi, Beas and Sutlej. The treaty also guaranteed ten years of uninterrupted water supply.

Post 1960: The Indus Water Treaty between India and Pakistan addressed both the technical and financial concerns and also included a timeline for transition. The main points of the treaty included an agreement *firstly*, that Pakistan would receive unrestricted use of the western rivers, which India would allow to flow unimpeded, with minor exceptions. *Secondly*, the provisions for three dams, eight link canals, three barrages, and 2500 tube wells to be built in Pakistan. *Thirdly*, a ten-year transition period (from April 1, 1960 to March 31, 1970) during which water would continue to be supplied to Pakistan according to a detailed schedule. Finally, India to provide fixed financial contribution of $62 million in ten annual installments during the transition period and additional provisions for data exchange and future cooperation (Alam, 2002). The Permanent Indus Commission, made up of one Commissioner of Indus Waters from each country was also the part of treaty and the commission would meet annually to establish and promote cooperation and also to submit an annual report to the respective governments. In addition, the treaty calls for either party, if it undertakes any engineering works on any of the tributaries, to notify the other of its plans and to provide any data which may be requested.

Evolution of irrigation infrastructure and institutions involves physical, economic, social attributes and the state policies (Kurian, 2004). The Indian Indus Basin of 321289 square kilometers, roughly 9.8 per cent of the total geographical area of the country, lies in the States of Jammu and Kashmir, Himachal Pradesh, Punjab, Rajasthan, Haryana and the Union Territory of Chandigarh (CWC, 2011). Irrigation has been the main input for the growth of agricultural production. Indian Punjab is a part of the Indus Basin in the north and north-west of Indian Sub-continent. The surface and

groundwater of the Indian Indus Basin constitutes the lifeline of Punjab's agro-based economy. Punjab faces major irrigation and drainage challenges with profound social, economic and environmental implications. Punjab government has developed a long term vision and strategy to provide adequate, equitable and reliable irrigation water to the cultivable land with a view at enhanced agricultural production and productivity and sustainable development with focus on holistic management. Indian Indus Basin comprises of three perennial rivers Ravi, Beas, Sutlej and one seasonal river Ghaggar (Map 2). The Ravi enters Punjab near Madhopur and flow on to Pakistan. The Beas enters Punjab near Talwara (Hoshiarpur) and joins Sutlej at Harike. The Sutlej enters Punjab near Nangal, passes through Ropar, Ludhiana and joins Beas at Harike and crosses over to Pakistan. The Ghaggar River enters Punjab near Mubarkpur from Haryana then flows through Punjab and re-enters Haryana.

Map 2: Indian Indus Basin, 2011



Canal System in Punjab

State of Punjab, comprising 1.5 per of the geographical area of the country, has been contributing around two third of wheat and half of the rice to the central pool. This has led to over exploitation of groundwater resources, as the surface water fall short of the irrigation needs of the State. Further, for water management issues and related water problems, Punjab can be divided into three water zones namely Shiwalik zone having 19 percent of State's geographical area, Central zone with 47 percent and South-Western zone with 34 percent. These water zones of Punjab have been facing water problems of different types. Shiwalik zone is prone to soil erosion, flash floods, deep water table etc. Central zone is facing a serious ground water depletion and pollution and South-Western zone is facing a poor quality of ground water due to salinity and

alkalinity (Jain and Kumar, 2007) and deficiency of canal water due to tail end of canal system (Bhangoo, 2006).

Development of Canals: Pre-Independence Era

Before 1947, headwork at Ropar was constructed in the year 1874-82 for utilizing water of river Sutlej in the old Sirhind Canal system and this system was developed on run off the river basis. Upper Bari Doab Canal (UBDC), one of the oldest canals in India was first built by Emperor Shah Jehan in the year 1693, for carrying water of River Ravi from Madhopur to Lahore. Improvements in the canals were made by Maharaja Ranjit Singh in the 19th century. Weir type headwork with a properly designed distributaries system was constructed by the British in 1879. At the time of partition, full supply discharge of UBDC during Kharif was 6900Cs. Hussainwala headwork was constructed in the year 1927 at Ferozepur for utilizing Sutlej/Beas waters through the Bikaner Canal/Eastern Canal. The pre-partition utilization of water of rivers Sutlej, Beas and Ravi in the areas of present Punjab forming part of the Indian Union, was 4.55 MAF, 0.50 MAF and 1.48 MAF respectively. The canal irrigation infrastructure in the pre-partition period was well maintained.

Development of Canals: Post-Independence Era

During post independence period, numbers of multipurpose projects were planned over rivers, Sutlej, Beas and Ravi. For better utilization of the stored water for irrigation, dams and reservoirs, substantial expansion of irrigation infrastructure by constructing additional network of canals and remodeling the existing canals has been initiated in Punjab. A brief account of major canal infrastructure is presented in table 1. Post independence network of canal covers the entire Punjab evenly.

Table 1: Details of canal infrastructure after independence

Sr. No.	Project Name	Year	River	Location
1.	Bhakra Dam	1963	Satlej	Bhakra (H.P)
2.	Nangal Dam	1948	Satlej	Downstream (Bhakra Dam)
3.	Nangal Hydel Channel	1954	Satlej	Nangal Dam
4.	Bhakra Main Line Canal	1950-54	Satlej	Extension of Nangal Hydel Channel
5.	Old Sirhind Canal System	1952-54	Satlej	Ropar Headworks
6.	Harike Headwork	1954-55	Satlej-Beas	Harike
7.	Madhopur Beas link	1955-57	Beas-Satlej	Madhopur
8.	Rajasthan canal	1958-1961	Satlej-Beas	Harike Headworks
9.	Ferozepur Feeder	1952-53	Ravi-Beas	Harike Headwork
10.	Pong Dam	1974	Beas	Pong
11.	Beas Sutlej Link	1977	Beas-Satlej	Pandoh (H.P.)
12.	Shanehar Headwork	1983	Beas	Downstream of Pong Dam.
13.	Mukerian Hydel Channel	1982	Beas	Shanehar Headwork
14	Ranjit Sagar Dam	2000	Ravi	Upstream of Madhopur Headworks
15	Shahpur Kandi dam	2006-07	Ravi	Downstream of Ranjit Sagar Dam

Source: Govt. of Punjab, Punjab Irrigation Department

Capacity and Length of the Canal System in Punjab

The canal irrigation system is fundamental mechanism for conveying water from sources to the fields. In Punjab, the construction of multipurpose storage dams on major rivers has gone a long way towards improving the regulation of water and spreading the supplies uniformly over the year (Jairath, 1985). Punjab has a well developed canal system in the country and capacity of main canals is shown in table 2.

Discharge capacity and the length of the canal system is indicative of the strength and coverage of the network.

Table 2: Capacity (discharge and length) of main canals of Punjab

Sr. No.	Canal	Discharge (Cusecs)	Length (Kms.)
1	Sirhind Canal	12622	59.44
2	Nangal Hydel Channels	14500	20.12
3	Combined Branch	7635	3.22
4	Sidhwan Branch	1751	88.01
5	Abohar Branch	3027	109.75
6	Bathinda Branch	2890	152.40
7	Ferozpur Feeder	11192	51.42
8	Sirhind Feeder	5264	136.53
9	Rajasthan Feeder	18500	149.53
10	Abohar Branch Lower	1693	46.37
11	Bikaner Canal	2720/3027	112.01
12	Eastern Canal	3929	8.02

Note: Total C.C.A. 30.88 Lacs Hectare
Source: pbirrigation.gov.in

In addition to the large dams on major rivers of the Indus Basin, Punjab has constructed other important dams in the State to generate hydro power and irrigation facilities in the state. The detail of these dams and reservoirs is presented in table 3. Dholbaha, Damsal and Thana have the highest Culturable Command Area (CCA), in order. These dams have been constructed under the World Bank support for the project, 'Kandi Area Water Shed Project' in the Shiwalik zone of the State.

Table 3: Important Dams of Punjab

Sr. No.	Name of the Dam	Location	Culturable Command Area CCA (Ha)
1.	Dholbaha	Hoshiarpur	3745
2.	Janauri	Hoshiarpur	492
3.	Maili	Hoshiarpur	914
4.	Damsal	Hoshiarpur	1920
5.	Chohal	Hoshiarpur	900
6.	Saleran	Hoshiarpur	365
7.	Patiari	Hoshiarpur	730
8.	Thana	Hoshiarpur	1160
9.	Perch	SAS Nagar	400
10.	Mirzapur	SAS Nagar	970
11.	Siswan	SAS Nagar	950
12.	Jainti	SAS Nagar	500

Source: pbirrigation.gov.in

Irrigation Water Delivery System

One of the basic and important objectives of the canal irrigation system is the delivery and distribution of water for irrigation among the water users. Due to the shortage of water in the system, the water is delivered to different parts of the canal system in rotation, i.e., using the 'Rotational Programme of Channels' (Gustafson and Reidinger, 1971). Supplies of irrigation water to the farmers have been awarded in the past by the system of '*warabandi'* based on equitable and proportionate water allowance. *Warabandi* is a rotational and proportional method for equitable allocation of the available water in an irrigation system. The twin objectives of *warabandi* have

been high efficiency and equity in water use and both objectives are to be achieved and guaranteed by self-policing rotation system (Bandaragoda, 1998). Further, *warabandi* is agreed upon by concerned farmers/users and appropriate canal authority. Though this system of distribution is intended to be fair but the unpredictability of water supply is being faced by the users. The problem of water supply unpredictability arises due to little or no institutional control mechanism over the rotation and rationing of water based on non-market mechanism. It is also clearly evident that trade-off between hydro power generation and irrigation, reservoir factors and capacity factors contribute to the uncertain water supply (Gustafson and Reidinger, 1971).

Presently, in Punjab *warabandi* system of canal water distribution and allocation among the water users is in operation. Further, mainly three types of *warabandi* are being used, namely: *khuli–wari* (open turn), *panchayati-wari*, and *weekly-wari*. Field staff of the Irrigation wing fixes the turn, duration and quantity of water for farmers. The basis for the distribution and allocation of water depends upon the size of the land holding, distance from the outlet (*mogga*), and certain other factors. That is the canal water distribution and allocation in Punjab has been carried out with little modifications in the *warabandi* system. Now attempt is being made to allocate and distribute water more scientifically through computerization of the distribution and allocation process.

Legal Framework, Water Disputes and Accords

The state of Punjab has been facing the problems like increasing demand for water from agriculture, depletion and pollution of ground water, pollution of water bodies, financial crunch to maintain and develop water resources, inter-state water disputes and their politicization and inadequacies of institutional reforms and enforcement.

In 1955, the Union government made possible to allocate 15.85 MAF waters of Ravi and Beas after excluding of pre-partition use of 3.13 MAF (Iyer, 2004). The agreed share of water by different States was Jammu and Kashmir (0.65MAF), PEPSU (1.30MAF), Punjab (5.90MAF) and Rajasthan (8.0MAF). The conflict arose due to reorganization of Punjab and Haryana in 1966 and the combined share of Punjab and PEPSU (7.2 MAF) to be divided between Punjab and Haryana (Box 2). In 1976, Government of India (GOI) by a notification under Section 78 of the Punjab Reorganization Act, 1966 settled water sharing dispute by allocating 3.5 MAF to each Punjab and Haryana and remaining 0.2 MAF to Delhi. At the same time Sutlej Yamuna Link (SYL) Canal was proposed for Haryana to fully use the allocated waters. Both States entered in to a legal dispute and approached the Supreme Court and the dispute gained a political twist. This conflict went on brewing for years between Punjab and Haryana. In 2004 Punjab Assembly terminated all water agreements by passing the 'Punjab Termination of Water Agreements Act, 2004'. Now, the dispute with the presidential reference is under the consideration of the Supreme Court.

The legal issues concerning the water sharing dispute have many dimensions: unilateral repudiation of agreements; Indus basin states and riparian rights; and reorganization of States (Iyer, 2004). The agreement reached on 4.22 MAF and 3.5 MAF for Punjab and Haryana respectively seems to be acceptable but the politics prevailed over it and agreement ran into rough weather once again. Whatsoever is the legality and fairness of the water dispute, Punjab has been ruined not only due to shortage of water but due to the political and religious fallouts. Punjab remained in turmoil for many years as this dispute has been a major contributor in invoking and fueling the terrorist situation.

Box 2: SYL Canal Politics and Litigation

1960: Indus Water Treaty, signed by India and Pakistan. It reserved waters of the Ravi, Beas and Sutlej exclusively for India.

1966: Punjab Reorganized (Nov. 1, 1966). New Haryana claims share of waters.

1976: Government of India announced that both the States would receive 3.5 MAF (million acre feet) of water from the available annual flow of 15 MAF. Haryana gets 1.62 MAF of allotted 3.5 MAF and balance had to be made available through the construction of SYL (Sutlej-Yamuna Link Canal). SYL starts from tail end of Anadpur Sahib Hydel Canal of Bhakra Nangal and goes up to the Western Yamuna canal in Haryana.

Conflict: Punjab considered formation of Haryana under the Punjab Reorganization Act 1966 as illegal. Act did not mention the sharing of Ravi waters while the 1976 decision of GOI does. There has been dispute over the amount of surplus water actually available for allocations. Distribution has been based on utilization of 1960 and not on actual use of 1976. The constitution provides full and exclusive powers to the States over water and hydel power. However when Punjab was bifurcated, the Punjab Reorganization Act, 1966 gave all powers to the Centre *ultra vires* to the constitution.

1976: Ministry of Water Resources, GOI unilateral notification: (Estimated surplus river water= 15.85 MAF; Punjab=3.5 MAF; Haryana=3.5 MAF; Rajasthan=8 MAF; J&K=0.65 MAF; Delhi=0.2 MAF). Ground Reality: The surplus water available to Punjab was mere 1.2 MAF. Govt. of Punjab (Giani Zail Singh, CM) asked for review of the notification.

1978: Govt. of Punjab (P.S. Badal) moved the petition in Supreme Court challenging the constitutional validity of the notification; Govt. of Haryana also went to Supreme Court for implementation of the GOI notification.

1981: Govt. of Punjab (Darbara Singh) withdraws the case, signed an agreement with Haryana and Rajasthan for revised allocation of surplus flow of Ravi and Beas based on 1921-60 flow data estimated at 17.17 MAF as Haryana=3.5 MAF, Rajasthan=8.60 MAF and Punjab=5.07 MAF. Agreement created a **furor** in Punjab. It was marked by protests and agitation by the Akalis. Haryana completes the first phase of SYL canal by 1982 at a cost of Rs.40 crores.

1985: Punjab accord between Prime Minister Rajiv Gandhi and Sant Harchand Singh Longowal. Resentment of people of Punjab was noted. To decide the shares, a tribunal under the retired Supreme Court Judge was set up. SYL to be completed by 1986. The interests of Punjab farmers will not be compromised.

1987: Justice Eradi concluded that States of Punjab, Haryana and Rajasthan use 3.106, 1.620 and 4.985 MAF respectively. Total use comes out to be 9.711 MAF and estimated surplus to be 6.6 MAF. It awarded 5.00 MAF to Punjab and 3.83 MAF to Haryana. It was a wrong arithmetic of allocating 8.83 MAF against the available 6.6 MAF. Punjab contested Justice Eradi Tribunal award on grounds of overestimated available water and under estimation use by Punjab farmers.

1988: Justice Eradi Tribunal adjourned because of violence in Punjab. It started re-functioning on order from the court, in 1997. Because of no clear outcome matter again goes to the Supreme Court.

2003: GOP (Amrinder Singh) files a plea in SC to refer the matter to larger bench. SC rejects the plea. SC, on Haryana's plea, orders GOI to appoint a central agency to complete the SYL canal by 2004. Punjab contests it.

2004: Punjab assembly passes '*Punjab Termination of Agreements Bill, 2004'* and termed the diversion of waters as contrary to National Water Policy. President refers the Bill to SC. GOP threatens to stop releasing water to other States. Subsequently due to challenges, appeals and re-appeals in the court, even the constructed part of SYL became a junk and land taken over for the purpose went unused. Presently the case is in the Supreme Court.

Source: Khurana (2006) and various newspapers.

Institutional Reforms

The debate on institutional reforms has largely been driven by the World Bank. Over the period of time, with the increasing participation by civil society institutions, the content and direction of the debate has been slowly transforming. The World Bank financed activities aim at higher productivity through a combination of factors like economic, institutional, agronomic, hydrological and ecological (Roopa, 2007). In order to achieve the aims of Reforms Programme, the visualization of World Bank is as follows: (a) Reducing irrigation subsidies that are extended to farmers in developing countries and ensuring that the farmers pay the full financial costs; (b) Promoting and setting up of water user associations so as to empower users to operate and maintain their systems, collect fees, hire professionals and manage water rights; (c) Modernizing and reforming public sector agencies in order to provide for the institutional set up that will aid the functioning for the water users associations; (d) Addressing the political economy of reforms by engaging comprehensively with the Governments; and (e) Kicking the larger agenda that will involve giving high priority to the development of crops that are less susceptible to droughts, floods and salt, that result in more production per unit of water use, that are less vulnerable to pests and spoilage and that use smaller quantities of water polluting fertilizers and pesticides.

Canal irrigation systems/projects provide increased and much needed food production self-sufficiency and food security across the globe. These considerations suggest that it is probably better to have a good workable institutional structure for more intensive use of water through improved water management in canal irrigated agriculture. The pre requisites of improved water management and reforms (Bromley et al. 1980) are follows: (a) Rehabilitation of existing projects in terms of modifying the distribution network; (b) More intensive operation and maintenance of this infrastructure; (c) More careful planning of cropping patterns and schedules; (d) Greater care in the allocation and scheduling of water both among and within systems; and (e) Greater enforcement of, or changes in, the rules and regulations governing access to irrigation water by individual farmers.

For proper and successful operation of the canal irrigation systems, it is believed that an efficient authority structure is the prerequisite. Furthermore all the large river and canal based irrigation systems of the world are widely assumed to require centralized authority (Hunt, 1988). It has not only been argued but also established evidence that there exists a positive relationship between central authority and size of the irrigation system (Wittfogel, 1957). All over the world, including Punjab, the vast majority of canal irrigation systems have a constituted authority structure (Hunt, 1988). In the process, the physical system must be constructed and maintained so that all the stakeholders of the system feel satisfied (Hunt and Hunt, 1976).

Punjab Canal Irrigation: Institutional Evolution

In an attempt to develop Punjab as a granary of the country, massive canal irrigation network came in to existence solely with the government effort. This involved various departments relating to irrigation, power and others. Initially, all these departments emerged as big public sector departments that helped in efficient creation, operation and management of the system. There was a sufficient autonomy in the operation and management of these departments. This provided not only the irrigation facilities but also abundant power and helped in controlling floods in the region. Over a period of time, irrigation related institutional setup deteriorated exactly in consonance with other public sector organizations. In the institutional evolutionary process of State

of Punjab, two events have been responsible for acting as a catalyst in making this deterioration to be fast and massive. *First* has been the inter-state water sharing dispute and other has been the free water and free electricity for irrigation. Interstate water sharing (the SYL row), became a political and religious issue rather than an economic issue. It derailed the State in the decade of eighties and nineties. A prosperous State, with highest per capita income, got converted into a battleground of fundamentalism and terrorism. This effected both investment and cost recovery in all the systems. *Second* has been the myopic political vision and quick buck political approach that resulted in subsidized diesel, free water and electricity for irrigation. This led to total neglect of the canal system and ruthless mining of the groundwater. Recent introduction of water charges in 2010 for canal irrigation are meaningless in the presence of subsidized diesel and free electricity for tube-well operation. In this transition, the system has nurtured a class of water users who are totally unaware of the scarcity of water resource. The condition has been further deteriorated by the State supported price mechanism for heavy water consuming crops: rice and wheat. Now, more than economic, it has become a political issue for successive governments; it is difficult to withdraw the freebees and introduce diversification by breaking the wheat-rice rotation. Water users in agriculture have no motivation and support mechanism to think for water saving crops. The evolution is indicative of the fact that irrigation institutional mechanism developed the agriculture in the region and provided the food security to the country. But political considerations with short sighted vision have parallelized the institutional set up. State is far below the best of the best available in India, what to talk about global comparisons.

As far as the canal irrigation system of Punjab is concerned, these have been controlled, maintained and operated by the government. In spite of massive investment in canal irrigation system of the state, the outcome has not been encouraging. In the Indian perspective, emphasis has been on construction of new projects rather than efficient management, operation and maintenance of existing irrigation systems (Mitra, 1992). The poor performance of canal irrigation of Punjab may be attributed to low productivity of irrigated, low return on investment due to free/low price of irrigation water, poor water distribution especially to tail-end users and underutilization of irrigation potential. Keeping in view above issues it is of paramount importance and need of the time that canal water irrigation reforms must be initiated in Punjab as early as possible. Reforms may be in tune with global perspective in which the canal irrigation system reforms has been driven to dismantle state monopoly and control; as public sector organizations miserably failed to maintain and efficiently operate irrigation projects and transfer these to water users, water user associations, *pachanyati raj* institutions and other stakeholders.

Punjab Canal Irrigation: Institutional Reforms

In India water is a state subject, further within a State major and medium irrigation projects are under the purview of State irrigation departments and minor irrigation projects are under local authorities. So there is a dire need for reforms in the canal irrigation system of the state. Punjab, in comparison to other states of India, initiated little or no institutional reforms in its canal irrigation system (Chowdhury and Torero, 2007). Thus, institutional reforms must be initiated with a focus on issues to improve the performance and financial viability of canal irrigation system, to make groundwater use both economically and environmentally sustainable for a smoother and systematic transition from water resource development mode to an integrated water resource management mode (Shah et al. 2004). Further, reforms may be initiated and

implemented in three major areas of canal irrigation system of Punjab: (a) rebuilding and refurbishment of canal system; (b) irrigation water management; and (c) irrigation policy initiatives.

Rebuilding and Refurbishment of Canal Irrigation System is a need of the hour. Presently the age old, depreciated and in dilapidated canal networks of Punjab requires an immediate rebuilding and refurbishment. Canal irrigation systems is performing far below the requirement and farmers are turning to groundwater for irrigation needs (Shah et al. 2004). Therefore, rebuilding and refurbishment of canal networks should be done at the earliest.

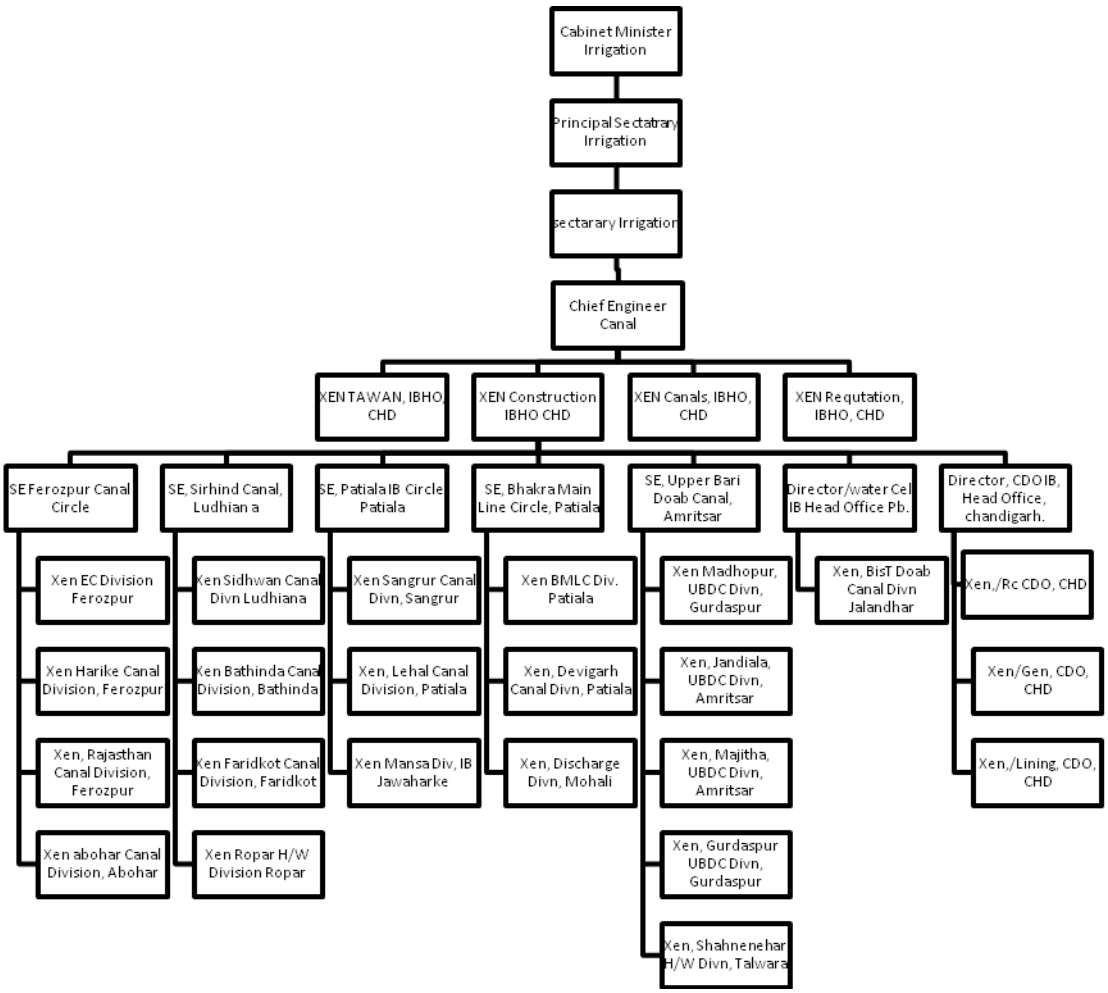
Irrigation water management Reforms is the next issue. Punjab must learn from experiences of Andhra Pradesh, as far as irrigation management initiatives are concerned. Andhra Pradesh has been the first state in India to introduce reforms on a large scale (Reddy, 2003). The objectives of Punjab canal irrigation management reforms should be the maximization of irrigational potentials, better management of existing canal infrastructure through active participation of stakeholders. The stakeholders of the system are: water users, water users associations, panchyats, farmers, NGOs and others. This requires a massive state initiative and political will, rather than short sighted political goals.

This is a high time to go in for *Irrigation Policy Reforms.* Canal irrigation policy and institutional reforms of Punjab must be targeted to regain lost credibility and build the trust. In this regard, *firstly*, the irrigation water should be converted into an economic good by introducing volumetric pricing. Initially populist politics and narrow political interest would be the hurdles but in the long period this would result in economic as well as political dividends (Reddy, 2003). *Secondly*, the participation of stakeholders and transfer of powers and responsibilities to locals would help in addressing problems. *Thirdly*, at present, the local bodies are bypassed in irrigation matters; therefore there is an urgent need to involve *panchayati raj* institutions in this process. *Fourthly*, in whole of the institutional reforms process, the ecological concerns must be taken into consideration. *Finally*, the distributional aspects should be looked upon essentially in terms of equal rights on water for all the stakeholders in the community. The policy framework needs to go much beyond the canal irrigation. It must consider total irrigation as a system that must include ground water resources, rationing the new tube-well electricity connections, electricity pricing, crop-diversification, diesel pricing and other ecological issues.

II
Organization Structure and Performance Evaluation

In Punjab, the organization and management of water and irrigation bodies and infrastructure has been the monopoly of the state. At the state level a Cabinet rank Minister of the State is heading the system and is assisted by a Principal Secretary, Secretaries, Superintendent Engineers (SEs), Sub Divisional Officers (SDOs) and the field staff. Organization structure and different divisions of the Irrigation Department of Punjab are as follows:

Organization Chart



Organization structure is indicative of the fact that the offices of irrigation branch and division are located at the places suited to the State bureaucracy rather than to the irrigation infrastructure and the stakeholders. The irrigational organizational structure should be recast so that the canal infrastructure is strengthened and user requirements and problems are redressed in time.

Performance Evaluation of the System

Punjab is predominantly an agrarian State having 85 percent of its geographical area under cultivation with an average cropping intensity of 189 percent. Water is the only natural resource available and the State is devoid of any other mineral or natural resources. Punjab's agriculture being highly intensive is dependent on heavy requirement of water. The present cropping pattern and the efforts to increase the productivity of food grains has led to immense strain on irrigation system due to limited surface water resources, which are grossly inadequate to meet requirements and this is causing stress on ground water resources. In the State, the surface water resources are being fully utilized through well-organized canal irrigation system. The available surface water is unable to meet the demand of agriculture; as such there is an increasing pressure on the ground water resource.

Structure and Pattern of Supply, Demand and Pricing in the System

Punjab, the major riparian State of Indian Indus basin, has a limited share in its three perennial rivers (Sutlej, Ravi and Beas). On ***supply side***, it has been allocated only 1.795 Million HaM (14.54 MAF) [2] out of a total average availability of 4.24 Million HaM (34.34 MAF)[2]. Its replenishable ground water resources are estimated at about 2.144 Million HaM (17.37 MAF)[2]. The total available water resources are 31.91 MAF against an estimated demand of 50 MAF[3], showing a deficit of 38 percent for a major riparian State. Punjab has about 14500 km long canal network (table 4) and about 1 lakh km of watercourses, providing irrigation to 1.15 million hectare, which is 28.19 percent of total cultivable area of the State (Year 2006-07). However, the network of canals, which is more than 150 years old, is unable to take its full discharge, as it requires major rehabilitation and rejuvenation. As a result of reduced carrying capacity of the system and decreased availability of surface water, the net-area irrigated by canals has gone down from 55 percent in 1960-61 to 28 percent in 2006-07. At present the canal water allowance, which has been in vogue since long, is 5.5 cusec per thousand acres in Eastern Canal system and 3.5 cusec per thousand acres in Sirhind Feeder system, which are getting water logged. But it is 1.95 cusec per thousand acres in Bist Doab Canal system, which is facing depletion in ground water. The canal water allowances need to be diverted from water logged areas to areas facing depletion in ground water.

Table 4: River Water System in Indian Punjab

Headwork	River	Canals
Nangal Headwork	Satlej	Bhakhra Main Line Anandpur Hydel Channel
Ropar Headwork	Satlej	Sirhind Canal Bist Doab Canal
Shah Nehar Canal System	Beas	Mukerian Hydel Channel Kandi Canal
Madhopur Headwork	Ravi	UBDC Canal Kashmir Canal
Harike Headwork	Satlej and Beas	Rajasthan Feeder Sirhind Feeder
Hussainiwala Headwork	Satlej and Beas	Bikaner Canal Eastern Canal

Source: *Statistical Abstract*, Govt. of Punjab, various issues

Continuous Growth in population, sowing of high-water consuming and high yielding cash crops and also expansion of economic activities has led to increasing demand of water for diverse purposes, causing a great stress on available water resources in the State. Agriculture in Punjab is primarily an artificial irrigation based, i.e., using surface as well as ground water resources. Intensive agriculture, based on wheat-rice rotation, has led to a serious imbalance in use and availability of ground resources. According to an estimate, the total water supply of 3.13 m ham falls short by 1.27 m ham of the total water demand of 4.40 m ham (Table 5). The deficit is met by over-exploitation of groundwater reserves through tube-wells and wells.

Table 5: Status of Water Resources in Punjab

Detail	m ham
Annual canal water at head-works	14.54
Annual canal water at outlets	1.45
Annual ground water available	1.68
Total annual available water resources	3.13
Annual water demand	4.40
Annual water deficit	1.27

Source: A.K. Jain and Raj Kumar (2007)

As a result, groundwater has become a major source of irrigation in the State. An analysis of net area irrigated in Punjab by source of irrigation (table 6) is indicative of the fact that only 28 percent of the total area is irrigated by surface water or canals and rest 72 percent area is irrigated by tube-wells and wells. The historical dependence on canals and other sources of surface water has gradually been reduced in favour of groundwater. On the eve of Green Revolution, there was an even dependence on both the sources of irrigation. The net area irrigated by canals came down from 44.53 in the year 1970-1971 to 42.28 percent in 1980-1981. It slightly rose to 42.47 percent in the year 1990-1991. It has settled around 27 to 28 percent in the last few years. On the other hand, because of easy availability of cheap or free electricity, the dependence on groundwater has drastically increased especially during the decade of 1990s. Presently, more than 70.68 percent of the net area irrigated in Punjab is dependent on tube-wells and wells, i.e., the groundwater. The availability of surface water resources is unable to meet the demand for agriculture and as such there is an increasing pressure on underground water resources. The ground water is being over exploited to meet increasing demand for diverse purposes i.e., intensive irrigation, drinking, industry and power generation.

Table 6 Net Area Irrigated in Punjab by Source (‘000 Hectare)

Year	Govt. Canals	Private Canals	Tube-wells	Others	Total
1970-71	1286	6	1591	5	2888
	(44.53)	(0.21)	(55.09)	(0.17)	(100)
1980-81	1430	-	1939	13	3382
	(42.28)	-	(57.33)	(0.38)	(100)
1990-91	1660	9	2233	7	3909
	(42.47)	(0.23)	(57.12)	(0.18)	(100)
2000-01	1002	-	3017	2	4021
	(24.92)	-	(75.03)	(0.05)	(100)
2002-03	1148		2880	7	4035
	(28.45)	-	(71.38)	(0.17)	(100)
2003-04	1129	-	2889	10	4028
	(28.03)	-	(71.72)	(0.25)	(100)
2004-05	1101	7	2919	8	4035
	(27.29)	(0.17)	(72.34)	(0.20)	(100)
2005-06	1134	4	2914	8	4060
	(27.93)	(0.10)	(71.77)	(0.20)	(100)
2006-07	1148	-	2878	46	4072
	(28.19)	-	(70.68)	(1.13)	(100)

Note: Figures in parentheses denote the percentages.
Source: *Statistical Abstract*, Govt. of Punjab, various issues

Regarding groundwater, in Punjab, there are two types of tube-wells: diesel operated and electric operated. Another important fact underscored by growth of

number of tube-wells (table 7) is that the total number of tube-wells that was 1.92 lakh in 1970-1971; rose to 6 lakhs in 1980-1981; to 8 lakhs in 1990-1991; to 9.3 lakh in 2000-01 and finally touched the level of 12.76 lakh in the year 2008-09. So over a span of past four decades, the number of tube wells has grown by more than 6 times. Further break-up of number of tube-wells into diesel and electric operated is indicative of the fact that with minor variations, the number of diesel operated tube-wells has remained fairly stable but the number of electric operated tube-wells has increased nearly by 10 times in the 30 years and much of this increase can be attributed to the current decade. The share of electric operated tube-wells has crossed the mark of 80 percent. The end of decade of 1990 has been characterized by concession to the farmers in the form of free electricity.

Table 7: Number of Tube-wells in Punjab (Lakhs)

Year	Diesel operated		Electricity operated		Total
	No.	Percent	No.	Percent	No.
1970-71	1.01	52.60	0.91	47.40	1.92
1980-81	3.20	53.33	2.80	46.67	6.00
1990-91	2.00	25.00	6.00	75.00	8.00
1998-99	1.70	88.54	7.45	81.42	1.92
1999-00	1.70	18.38	7.55	81.62	9.25
2000-01	1.70	18.18	7.65	81.82	9.35
2001-02	1.75	18.42	7.75	81.58	9.50
2002-03	2.91	25.30	8.59	74.70	11.50
2003-04	2.88	25.17	8.56	74.83	11.44
2004-05	2.88	24.66	8.80	75.34	11.68
2005-06	2.88	24.14	9.05	75.86	11.93
2006-07	2.80	22.73	9.52	77.27	12.32
2007-08	2.75	22.07	9.71	77.93	12.46
2008-09	2.80	21.94	9.96	78.06	12.76

Source: *Statistical Abstract*, Govt. of Punjab, 2009

Widespread rural electrification coupled with a flat-fee electricity subsidy that has led to a dramatic increase in the number of tube-wells, groundwater-based irrigation now far surpasses surface water use. In the absence of any systematic policy to regulate the demand for water, the unconstrained mining of this resource has resulted in over exploitation of groundwater. As per table 8, the present groundwater development is 145 percent as on March 2004. Out of 137 blocks of the State, 103 blocks are "over exploited", 5 blocks are "critical", 4 blocks are "semi-critical" and 25 blocks are in "safe category". A look on the temporal dimension of categorization of blocks shows that in year 1984 only 44.92 percent were the "overexploited" blocks and about 49 percent blocks were semi-critical or safe. But in the year 1992, 52 percent of the blocks went into the category of "over exploitation" and share of semi-critical and safe went down to 40 percent. Presently as per the 2004 statistics, the number of "over exploited" blocks has gone to 75.18 percent and the number of "semi-critical" and "safe" blocks has shrunk to 21 percent. Thus, over exploitation of groundwater and reduced share of canal water is drastically depleting the only natural resource of the Punjab economy. On the whole, the area underlain by groundwater of unfit quality is around 7957 square kms which comes out to be 16 percent of Punjab State.

Table 8: Categorization of Blocks on the Basis of Groundwater Draft in Punjab.

Year	1984		1986		1989		1992		1999		2004	
Category of Block	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Dark (Over-Exploited)	53	44.92	55	46.61	62	52.54	63	53.39	73	52.90	103	75.18
Dark/ Critical	07	05.93	09	07.63	07	05.93	07	05.93	11	07.97	05	03.65
Grey/ Semi Critical	22	18.64	18	15.25	20	16.95	15	12.71	16	11.59	04	02.92
White/ Safe	36	30.51	36	30.51	29	24.58	33	27.97	38	27.54	25	18.25
Total	118		118		118		118		138		137	

Source: Central Ground Water Board, Punjab.

To some extent, ***water logging and soil salinity***, is also the byproduct of the irrigation system in the State. Punjab state is characterized by two distinct topographical and hydro-geological settings: high yielding fresh groundwater regions in northern and central districts and the saline groundwater regions in south western districts. While groundwater is declining alarmingly in fresh water regions, it has risen steadily in saline groundwater regions in Muktsar, Bhatinda and Faridkot districts. As per a study of Central Soil Salinity Research Institute (CSSRI), the region, irrigated with Sirhind canal and an extensive distribution network, is experiencing extreme instances of water logging and soil salinity problems (Kamra, 2007). The problems are particularly severe in depressional locations which have inadequate or non-functional surface drains. The original cotton/*bajra*/maize–wheat/gram system has been replaced by rice-wheat rotation resulting from leveling of extensive sand dunes and conversion to irrigated fields. The area under cotton has been affected by the rising water table and farmers are not keen to grow cotton. River Sutlej in the western part of these districts is the main drain for the area. The water table has been rising steadily over the last three decades reaching within 1m or less from the surface over large areas. The problem is widespread over all blocks (Malout, Muktsar, Lambi and Giddarbaha) of Muktsar district; the water table rises virtually to the surface in a number of villages during rainy season causing serious damage to standing crops.

Study suggested both short and long term policy measures. The *short term measures* are: (a) provisions of regular electricity supply be made for pumping of drainage water from two subsurface drainage systems in Jammuana and Dodanwali villages; (b) implementation of a few projects on integrated farming systems for management of waterlogged saline groundwater regions involving ponds in combination with fisheries, horticultural and agro-forestry trees (bio-drainage); and (c) introduction of salt resistant crop/tree varieties developed at CSSRI in the waterlogged saline groundwater areas of Punjab. The *long term measure* is to develop a comprehensive long-term master plan needs to be developed for South-Western Punjab. It should aim to identify location specific measures based on drainage (surface, subsurface, bio and tube-well including skimming structures), integrated farming systems, micro-irrigation systems and agronomic/varietal interventions. Efforts should also aim to work out the regional water and salt balances which may require considerable improvement in current monitoring systems

The scope to address the supply side of water is limited and the major scope lies in managing the ***demand front*** of water. The state has gone from growing a previously healthy mix of crops such as wheat, maize, pulses and vegetables to devoting nearly 80 percent of its crop area to rice and wheat, two of the most water-intensive crops. Overall, central and state level agriculture policy–consisting of minimum support

prices, effective procurement of selected crops, input subsidies benefiting farmers in electricity, fertilizer, and irrigation and the increased availability of credit facilities over the years has played a key role in pushing farmers to grow primarily wheat and rice at enormous detriment to water resource sustainability in the country. The rice crop has been the most remunerative crop relative to other Kharif crops. As shown in table 9, it is also the most water intensive crop, using about 24000 cubic meters of water per hectare, which is about six times of maize, almost 20 times of groundnut and about 10 times of pulses. There is an urgent need of the time to change the cropping mix of the State to save the precious water resources.

Table 9: Water requirements of different crops in Punjab, India

Crop	Water requirements (Cub m per ha)	Electric Motor (hrs per ha)
Paddy	24181	290
Wheat	5504	60
Maize	5474	50
Barley	4486	35
Kharif Pulses	2355	35
Gram	2243	30
Rabi Pulses	2187	30
Groundnut	1123	35

Source: Karam Singh and K.K. Jain (2002)

On ***pricing front***, the blame for deteriorating water table goes to the State government's long-standing policy of giving free power to farmers. As power in Punjab is heavily subsidized, its 11 lakh agricultural consumers feel free to run their powerful submersible motors to draw groundwater. The supply of free power to farmers is directly linked with underground water. It leads to over exploitation of this scarce natural resource. During the years when electric supply was free in Punjab, the water table in some districts had gone down considerably and farmers are still going deeper in search of water by installing deep submersible pumps using heavy-duty motors consuming more power.

The rice growers have benefitted the most from its state managed effective minimum support price as well as from the electric supply (there are 8.56 lakh electric tube-wells out of 11.44 lakh), and even more so from the free electricity supply during 1997-2002 and beyond. The subsidized and sometimes even totally free electricity to the farm sector in Punjab has done more harm than good. Some of the studies are indicative of the fact that even if the electricity is priced at cost and charged on use basis (metered), rice still remains to be the profitable alternative (Karam Singh Gill, 2003). This is high time to reduce the area under paddy and introduce the alternative crops particularly in the Malwa region, to restore the water balance in the long run. The alternative crops (like groundnut, maize, pulses: arhar and moong) have to made competitive with paddy. In addition to water saving, the society will benefit in terms of improvement/ decline in soil degradation of fertility in the long run, improvement in sanitation and health, improvement in environment and power saving. Big chunks of Govt. budget goes for buying costly power from other states and divert funds from high value added sectors to this sector. Such savings need a detailed study fortified with a larger database.

Financial Evaluation of the System

Irrigation system in India are largely maintained and managed by the Government. The operational efficiency, however, hinges on the availability of requisite finances for the operation and management of the system on a self-sustainable basis. Public funds have been able to create large infrastructure for water resources development. The system should be able to generate the necessary funds from the users for the services received by them. In India, in practice, the revenue realized is grossly inadequate even to incur the day to day operational expenses. A rationalization of the charges for users is must to make them understand the scarcity value of water for its optimal utilization and meet the requirement of efficiency and equity in delivery of services by the participating service providers. It is in this context the analysis of financial performance is important to get an insight into the factors responsible for low performance.

Water Pricing

As per an earlier study by Dhawan, B.D. (1997), the large scale irrigation is synonymous with canal irrigation in India and canal irrigation is a costly proposition, more so when provided under the aegis of grave inefficiencies in project implementation and canal operation. To irrigate one crop hectare with canal water, it costs the nation Rs. 2277 in fixed and variable expenses. Barely 5 percent of this cost is recovered through irrigation charges levied on farmers. Further the study advocated that net of inflation, marginal cost of canal irrigation tended to rise by 8 percent per annum in the recent years. With such a rising marginal cost, it is far from possible to keep the canal irrigation a viable proposition.

The water rates should be adequate to cover the annual maintenance and operational charges and a part of the fixed cost of irrigation works. Efforts should be made to reach this ideal over a period of time while ensuring assured and timely supplies of irrigation water. The water rates for surface and ground water should be rationalized with due regard to the interest of small and marginal farmers. Box 3 gives the historical account of this water rates debate in India.

Arunachal Pradesh, Andaman & Nicobar Island, Nagaland, Meghalaya, Mizoram, Puduchherry and Lakshadweep have not levied any water charges for using water for irrigation purposes. The Government of Punjab which was, however, having specified water rates for use of water for irrigation purposes earlier, had abolished the same since February 1997 and again continued since 12th November 2002. On the other hand, the Government of Tripura which was not charging any amount for water used for agriculture is in the process of levying water charges for irrigation purposes. Also, the States like Sikkim and Arunachal Pradesh are in the process of introducing water charges for usage of water for irrigational purposes. In Punjab, the water rates have been recently revised with effect from 28-01-2010 (table 10). The rate for supply of canal water is Rs. 375/-per hectare per year payable by the shareholders of the *chak* of the canal outlet. The water rates are recoverable in two equal installments payable by 31st May and 30th November respectively every year.

Box 3: Water Rates Debate in India

British Days: The irrigation works in India were treated as commercial undertakings and only such schemes were sanctioned which could ensure recovery sufficient for annual expenses on operation and maintenance and also meet the interest charges on loan raised.

Post Independence Period: Irrigation came to be viewed as a necessary infrastructure for agriculture. This resulted in reduction the rates from 6 percent to 3.75 percent in 1949.

Gadgill Committee Report (1964): Benefit Cost Ratio (BCR) criteria adopted for the approval of irrigation projects. BCR ultimately resulted in the decline of cost recovery collection over time.

Second Irrigation Commission (1972): Recommended that user should pay and not the general tax payer.

The National Water Policy Statement (1987): "*The Water Rates should be adequate to cover the Annual Maintenance and Operation Charges and a part of the fixed costs of irrigation works. Efforts should be made to reach this ideal over a period of time while ensuring assured and timely supplies of irrigation water."*

Vaidyanathan Committee (1991): Expressed serious concern on inadequacy of funds allotted for O&M expenditure. The Committee recommended for an allocation of 10 percent of Plan provision for Major and Medium Projects for renovating the existing system and earmarking the recovery of accumulated arrears towards the cost of deferred maintenance/special repairs in the projects concerned. It also recommended for enhancement of water rates to cover O&M and interest on capital cost with depreciation. On this report, later a committee of officials appointed by Govt., recommended that the irrigation charges be raised in a phased manner over a period of five years taking in to account inflation also to cover full O&M costs.

The National Water Policy Statement (2002): Advocates for "*the water charges for various uses and should be fixed in such a way that they cover at least the Maintenance and Operation charges of providing the service initially and a part of the Capital Costs subsequently. These rates should be linked directly to the quality of service provided. The subsidy on Water Rates to the disadvantaged and poorer sections of the society should be well targeted and transparent".*

Successive Finance Commissions: Commissions also advocated for improving the cost recovery. The 13th Finance Commission, also suggested to enhance operation and maintenance cost in course of 11th Five Year Plan and thereafter. Detailed recommendations of the 13th Finance Commission are as follows:

i) Receipts from irrigation have been estimated on cost recovery basis at 23 per cent of the non-plan revenue expenditure on irrigation, which is very low and needs to be improved in order to ensure viability of irrigation projects. The 13th Finance Commission normatively recommended enhancing receipts from irrigation from 25 per cent of non-plan revenue expenditure on irrigation in 2010-11 to 35 per cent in 2011- 12, 45 per cent in 2012-13, 60 per cent in 2013-14 and 75 per cent in 2014-15.

ii) Given the need for adequate provision for maintenance of irrigation schemes, the Commission has adopted the norm of Rs. 1175 per hectare for the utilized potential and Rs. 588 per hectare for the unutilized potential for major and medium irrigation schemes. After adjustment for inflation, with an annual growth of 5 per cent thereafter, these would reach the level of Rs. 1500 per hectare for utilized and Rs. 750 per hectare for unutilized potential in the terminal year (2014-15).

iii) For minor irrigation works, the Commission has provided the norm of Rs. 588 per hectare in the base year for only the utilized potential. However, the Commission has allowed a 30 per cent step up on these norms for the special category states.

Table 10: Water rates for irrigation and other purposes in Punjab

Purpose	Season (crop)	Water rate (Rs./unit)	Date of enforcement
Irrigation	Flow Irrigation		
	Rabi Season(Paddy, Cotton, Maize, Sugarcane, Other crops)	375.00/ha	28.01.2010
	Kharif Season (Wheat, Other crops)	375.00/ha	-do-
	Lift Irrigation		
	Rabi Season(Paddy, Cotton, Maize, Sugarcane, Other crops)	375.00/ha	-do-
	Kharif Season (Wheat, Other crops)	375.00/ha	-do-
Other Purposes	Domestic		
	Drinking	12.00/6000 cft	13.02.2003
	Bulk Supply	32.00/2500 cft	-do-
	Commercial		
	Drinking	12.00/6000 cft	-do-
	Other Uses	32.00/2500 cft	-do-
	Miscellaneous		
	Brick Making	32.00/2500 cft	-do-
	Modeling Roads	32.00/2500 cft	-do-
	Consolidation of Kucha Roads	32.00/2500 cft	-do-

Source: CWC, *Pricing of Water in Public System in India*, 2010, p 209.

Water Pricing Incentives

In spite of strong recommendations, most of the States and Project Authorities/Corporation remained unsuccessful in realizing even the Operation Management (O&M) costs of irrigation systems despite initiatives taken by the Union Government. With a view to encourage the States for bringing out the reforms in irrigation sector, in particular to increase the water rates so as to meet O&M costs of various irrigation projects, incentive have been provided under Accelerated Irrigation Benefit Programme (AIBP). Under the AIBP, the States which agreed to rationalize water rates in phases over a period of 5 years to recover full O&M costs were termed as Reforming States. These States were given more attractive offer of assistance under AIBP. Seven States namely Gujarat, Maharashtra, Andhra Pradesh, Madhya Pradesh, Orissa, Rajasthan and Jharkhand were declared reforming States but Gujarat could only meet the requirements. Under AIBP, optimum utilization of irrigation potential created is considered utmost priority and central loan assistance as well as grants for infrastructure development is released to the State Governments. The AIBP was conceived in the year 1996 by the Government of India in order to provide financial assistance to States to complete various ongoing projects in the country so that envisaged irrigation potential of the projects could be created and thereby extend irrigation to more areas. Since its formulation, the terms of the programme have been widened and liberalized over the time.

Table 11: State-wise Status of AIBP Central Loan Assistance (CLA)/Grant released for major, medium & ERM projects in India

Sr. No.	State	CLA released up to 2004-05	Grant released total up to 21.01.2009	Cumulative CLA/grant released	Percentage share
1	Andhra Pradesh	933.61	2544.36	3475.97	12.24
2	Assam	98.05	50.02	148.07	0.52
3	Bihar	454.90	118.94	573.84	2.02
4	Chhattisgarh	267.33	75.45	342.78	1.21
5	Goa	130.86	49.70	180.55	0.64
6	Gujarat	4107.17	1344.86	5452.03	19.19
7	Haryana	78.03	12.51	90.54	0.32
8	Himachal Pradesh	60.11	90.41	150.51	0.53
9	Jammu & Kashmir	75.80	188.60	264.40	0.93
10	Jharkhand	77.81	25.66	103.47	0.36
11	Karnataka	2269.01	1050.63	3319.64	11.69
12	Kerala	123.70	40.84	164.54	0.58
13	Madhya Pradesh	1866.69	955.31	2822.00	9.94
14	Maharashtra	979.89	2816.33	3792.22	13.35
15	Manipur	102.90	330.81	433.71	1.53
16	Meghalaya	873.16	1167.29	2040.45	7.18
17	Punjab	415.47	39.82	455.29	1.60
18	Rajasthan	1387.43	542.92	1930.34	6.80
19	Tripura	30.92	27.27	58.19	0.20
20	Uttar Pradesh/Uttaranchal	1914.54	492.30	2404.84	8.47
21	West Bengal	166.13	34.40	200.54	0.71
	Total	16413.51	11998.43	28403.92	100.00

Source: CWC, *Financial Aspects of Irrigation Projects in India, 2010*

The State-wise status of Central loan assistance and grant released under AIBP for major, medium and ERM projects in India are given in table 11. The central loan

assistance for Rs 16413.51 crore up to 2004-05 and grant of Rs 11998.43 crore up to 2008-09 have been released. Under AIBP scheme, cumulative grant released is oddly distributed among the States. The reason being: the requirement of a particular state or the availability of matching grant. The States like Gujarat, Maharashtra, Karnataka, and Andhra Pradesh got the significant (more than 10 percent each) chunk of grant/loan under this scheme. Share of Punjab in the cumulative CLA/grant released for the country is just 1.60 percent. It has been because of the lack of state initiative and poor financial resource mobilization. Age old irrigation system is deteriorating because of the non-availability of funds. Punjab used it for four projects and completed following two projects: 'Ranjit Sagar' and 'Remodeling of UBD'.

Financial Position Analysis (Major and Medium Projects)

Generally capital expenditure is a planned expenditure, whereas working expenses is recurring in nature and made from non-plan expenditure. The working expenses are a combination of direction & administration, plant & machinery and operation & maintenance cost. On the other hand gross receipt includes water rates and other charges. An analysis of capital expenditure, working expenses and gross receipts for major and medium irrigation projects in Punjab in relation to India, over the period 1990-2007, is given in table 12. Capital expenditure is the expenditure made for an asset with a useful life of more than one year that increases the value or extends the useful life of the asset. By practice, capital expenditures are not deducted in the year they are paid; they are capitalized and generally may be depreciated or amortized in the succeeding years. Working expenses are money spent for creation of asset/infrastructure in a fiscal year to add or expand infrastructure, plant and equipment assets and upkeep them with the expectation that they will benefit the government department over a long period of time. Gross receipts are the total amounts the organization received for taxes, fees, permits, licenses, interest, intergovernmental sources and other sources during its annual accounting period without subtracting any cost or expenses. Capital expenditure in state of Punjab has been in the range of 3 to 5 percent of total capital expenditure in India. In the beginning of decade of nineties, 3.14 percent of the total countries capital expenditure on major and medium irrigation projects has been in Punjab; it touched the level of 4.49, 4.72, 4.59 and 4.96 and 4.90 in successive five years of IX Five Year Plan (1997-98 to 2001-02). During the years, when water charges were abolished, capital expenditure on irrigation, in percentage share terms, was at all time high in the country. In the years of tenth five year plan, share of Punjab in country's total capital expenditure started sinking and gradually came down to an all time low of 3.20 percent. On the other hand working expenses of the system in Punjab as a percentage of India that were just 2 to 3 percent during the years 1994-95 to 2002-03, touched the all time high of 6.35 percent and 5.69 percent in years 2003-04 and 2005-06 respectively. So tenth plan period is characterized by decline in capital expenditure and increase in working expenses share of Punjab in relation to the total country. Punjab's share in the gross receipts of total country that used to be in the range of 6 to 7 percent up to 1996-97, came down drastically, following the withdrawal of water charges for irrigation. In year 2003-04, it touched the all time low level of just 1.19 percent.

The growth profile analysis of the system shows that long term growth rate of capital in Punjab (11.43 percent) has been higher than the Indian average (10.81 percent). Compound annual growth rate of working expenses in Punjab has been 10.88 percent as against 8.07 percent for total economy. Gross receipts for Punjab have grown at the rate of 2.91 percent per annum against 11.20 percent for the total country. Plan-wise breakup of financial parameters show that, in the X Plan, annual capital

expenditure growth in Punjab has been 5.14 percent against 15.48 percent in the country; working expenditure growth has been other way round, it was 13.26 percent per annum in Punjab against 4.41 percent for the country. Gross receipt for Punjab has grown at 3.60 percent per annum against 15.45 percent for the country. In the recent years, the recovery of working expenses has also deteriorated. Financial management of major and medium projects of the State of Punjab is in bad shape. In the recent past, capital expenditure has gone down, working expenses are on the rise and gross receipt is shrinking. It shows that irrigation projects of the State are in a complete state of neglect. Poor recovery of working expenses leaves hardly any resources for the upkeep and maintenance of the system. Major reason is the poor resource mobilization and the inability of State to generate the matching grants for central assistance.

Financial Position Analysis (Minor Projects)

Financial scenario of minor irrigation projects in Punjab, in relation to India, is given table 13. Consistently over the years, the capital expenditure on projects in Punjab as a proportion of the expenditure done in the country has been in the range of 1.08 to 1.63 percent. Likewise the share of working expenses on minor projects in Punjab, as a proportion of the total country, ranged from 1.25 to 4.86. An important fact to be noted during the period under consideration is that, both in capital expenditure and working expenses, there has been a significant improvement in the post 1997-98 period. As expected, the percentage share of Punjab in gross receipts of total country has deteriorated in the post 1997-98 period. Overall growth rate of capital expenditure (9.66 percent) and working expenses (9.01) percent, in Punjab has been higher than that of the country; which was 7.92 percent for the capital expenditure and 4.92 percent for the working expenses. Against 6.70 percent per annum annual growth rate of gross receipts at country level; there have been -4.37 percent per annum growth in the Punjab State. Thus in terms of both percentage share and annual growth rates, the capital expenditure and working expenses has been above the country average mark but the receipt side deteriorated. Being granary of the country, the demand-wise heavily loaded irrigation system needs a massive investment and this calls for a massive special assistance package.

Table 12: Capital expenditure, working expenses and gross receipts for major and medium irrigation projects in Punjab in relation to India over 1990-91 to 2006-07 (Rs in lakhs)

Year	India			Punjab			Punjab as a percentage of India		
	Capital Expenditure	Working Expenses	Gross Receipt	Capital Expenditure	Working Expenses	Gross Receipt	Capital Expenditure	Working Expenses	Gross Receipt
1990-91	3055690.63	245219.47	22415.44	95986.54	8749.40	1416.30	3.14	3.57	6.32
1991-92	3368877.25	279020.93	22741.51	112519.98	9531.25	1511.33	3.34	3.42	6.65
1992-93	3710509.11	316212.65	32029.06	131042.97	10889.90	1579.88	3.53	3.44	4.93
1993-94	4108038.35	362984.64	47757.53	157523.61	11174.65	1641.21	3.83	3.08	3.44
1994-95	4588559.02	435244.04	44446.07	191833.77	12056.57	3145.64	4.18	2.77	7.08
1995-96	5134688.60	481852.60	49542.99	234417.46	13542.43	3014.15	4.57	2.81	6.08
1996-97	5684071.95	544564.14	45839.19	238363.44	15432.34	2764.11	4.19	2.83	6.03
1997-98	6398415.12	625791.61	36334.13	287494.32	16766.52	1068.83	4.49	2.68	2.94
1998-99	7107785.75	721538.19	44180.30	335786.10	18586.56	1627.57	4.72	2.58	3.68
1999-00	7895283.28	798021.72	45694.45	362376.70	19025.92	1769.00	4.59	2.38	3.87
2000-01	7819722.37	876242.07	75351.72	388217.81	22065.98	1168.19	4.96	2.52	1.55
2001-02	8584670.24	823918.53	65224.50	420310.94	22211.83	1633.32	4.90	2.70	2.50
2002-03	9600786.39	884590.08	78338.87	448952.08	24822.64	2447.10	4.68	2.81	3.12
2003-04	11047270.74	629360.20	104760.26	453619.80	39945.83	1244.38	4.11	6.35	1.19
2004-05	12844465.21	701831.40	126415.03	497693.25	33399.06	9096.49	3.87	4.76	7.20
2005-06	15040964.55	821604.63	119470.28	514993.04	46708.93	2616.84	3.42	5.69	2.19
2006-07	16897977.28	960443.12	150465.91	541378.64	42786.37	2014.08	3.20	4.45	1.34
Compound Annual Growth Rates									
All data	10.81	8.07	11.20	11.43	10.88	2.91	-	-	-
VIII Plan	11.36	14.69	7.83	17.28	9.30	18.85	-	-	-
IX Plan	7.07	7.73	18.58	9.47	7.62	5.30	-	-	-
X Plan	15.48	4.41	15.45	5.14	13.26	3.60	-	-	-

Source: CWC, *Financial Aspects of Irrigation Projects in India, 2010*

Table 13: Capital expenditure, working expenses and gross receipts for minor irrigation projects in Punjab in relation to India over 1990-91 to 2006-07 (Rs in lakhs)

	India			Punjab			Punjab % of India		
Year	Capital Expenditure	Working Expenses	Gross Receipt	Capital Expenditure	Working Expenses	Gross Receipt	Capital Expenditure	Working Expenses	Gross Receipt
1990-91	545944.67	92170.42	4192.82	5882.08	1968.72	28.63	1.08	2.14	0.68
1991-92	592887.22	95324.18	5411.39	6535.27	2053.22	31.53	1.10	2.15	0.58
1992-93	650295.82	87918.31	5847.18	7329.25	2033.33	13.84	1.13	2.31	0.24
1993-94	713829.02	137725.28	6898.29	8224.00	2484.46	15.78	1.15	1.80	0.23
1994-95	789824.79	151046.52	9884.48	9317.88	2639.34	25.42	1.18	1.75	0.26
1995-96	865457.87	164344.71	11152.40	10304.90	2260.93	28.46	1.19	1.38	0.26
1996-97	853313.71	177534.52	10384.18	11305.90	2442.92	22.82	1.32	1.38	0.22
1997-98	1043935.60	173728.34	11592.47	12444.93	2177.54	1074.31	1.19	1.25	9.27
1998-99	1134623.52	191290.55	10137.10	14097.97	2824.64	10.99	1.24	1.48	0.11
1999-00	1260401.86	147521.52	9526.09	15571.44	3841.15	11.93	1.24	2.60	0.13
2000-01	1039678.56	173324.38	8013.87	16919.58	5003.06	41.18	1.63	2.89	0.51
2001-02	1143517.22	182978.71	8015.06	18152.59	5626.50	11.69	1.59	3.07	0.15
2002-03	1250255.61	174132.88	10117.79	18988.07	4613.60	13.30	1.52	2.65	0.13
2003-04	1411132.67	165957.24	12791.14	19934.04	4414.09	13.58	1.41	2.66	0.11
2004-05	1658086.99	196032.78	14468.48	21437.69	9526.73	17.67	1.29	4.86	0.12
2005-06	1946487.64	209697.08	16977.85	23945.38	8217.94	18.09	1.23	3.92	0.11
2006-07	2026137.20	239643.52	17731.78	26630.83	4366.33	12.72	1.31	1.82	0.07
Compound Annual Growth Rates									
All data	7.92	4.92	6.70	9.66	9.01	-4.37	-	-	-
VIII Plan	7.64	17.14	17.69	11.54	2.77	17.23	-	-	-
IX Plan	0.95	0.05	-9.27	9.83	28.02	-53.79	-	-	-
X Plan	13.74	9.12	15.09	8.98	5.25	2.00	-	-	-

Source: CWC, *Financial Aspects of Irrigation Projects in India, 2010*

Financial Position Analysis (Command Area Development Programme)

Command area development programme deals with development of geographical area under the command of river valley projects through centrally sponsored or central sector scheme implemented by the State/Central Government for constructing field channels, drainage, system and land leveling of undulating land of farmers. Reclamation of alkalinity and salinity of land are also carried out through command area development programme. A synoptic view of the evaluation of this programme is given in table 14. Under command area development, significant capital expenditure has been done in this decade. Share of Punjab in capital expenditure, done at the country level, has improved from just 1.43 percent in 1998-99 to 14.14 percent in 2006-07 and it is continuously on the rise. This has helped in strengthening the irrigation system of the State.

Table 14: Expenditure under 'Command Area Development Programme' irrigation projects in Punjab in relation to India over 1990-91 to 2006-07

(Rs in lakhs)

Year	India		Punjab		Punjab as a percentage of India	
	Capital Expenditure	Working Expenses	Capital Expenditure	Working Expenses	Capital Expenditure	Working Expenses
1990-91	46180.29	20498.19	-	-	-	-
1991-92	53392.14	21010.39	-	-	-	-
1992-93	60604.48	21070.29	-	-	-	-
1993-94	68880.37	24725.17	-	-	-	-
1994-95	77218.73	26800.49	-	-	-	-
1995-96	86189.00	33426.58	-	-	-	-
1996-97	99691.03	29815.88	-	-	-	-
1997-98	110659.69	31770.57	-	-	-	-
1998-99	122613.92	33565.04	1757.50	-	1.43	-
1999-00	133544.29	35638.84	3557.50	-	2.66	-
2000-01	147615.93	39439.83	10399.41	-	7.04	-
2001-02	162838.65	35533.93	17220.49	-	10.58	-
2002-03	172539.98	46489.12	19962.75	-	11.57	-
2003-04	180820.92	43009.97	21162.75	-	11.70	-
2004-05	194770.54	36345.38	24695.54	-	12.68	-
2005-06	211329.68	42331.21	28468.37	-	13.47	-
2006-07	228624.56	46152.25	32327.58	-	14.14	-

Source: Source: CWC, *Financial Aspects of Irrigation Projects in India, 2010*

Project-wise Cumulative Expenditure

Project-wise distribution of cumulative capital expenditure in Punjab (table 15) up to the year 2006-07 shows that capital expenditure is not evenly distributed among different projects. Capital expenditure on Nangal dam only constitutes 57.28 percent of the total expenditure. It is followed by 'Irrigation facilities to HP area below Talwara' project which constitutes 12.85 percent of the cumulative capital expenditure in the State. Rest of 30 percent of capital expenditure has been destined to 30 projects in the State.

Table 15: Project wise cumulative capital expenditure up to 2006-07 in Punjab on major and minor projects in Punjab

Sr. No.	Project	Cumulative capital expenditure up to 2006-07	
		Rs. In Lakhs	Percent
1	Beas Project	9293.86	1.73
2	Bhakra Dam	10323.10	1.92
3	Construction of new distributaries Minor	8622.31	1.61
4	Shah Nahar Canal System	17087.37	3.18
5	Extension of Phase-II Kandi Canal	7655.08	1.43
6	Irrigation Facilities to HP area below Talwada	7362.75	1.37
7	Lining of canals	68938.86	12.85
8	Low Dam in Kandi area	22256.89	4.15
9	Modernization of existing canals	14933.24	2.78
10	Nangal Dam	6928.48	1.29
11	Ranjit Sagar Dam	307358.15	57.28
12	Shah Nahar Canal System	5751.18	1.07
13	Shahpur Kandi Project	13962.56	2.60
14	Sirhind Feeder Project	14746.79	2.75
15	Satlej Yamuna Link Project	9027.69	1.68
16	Others 23 Projects	12337.61	2.30
	Total	536585.92	100.00

Source: Source: CWC, *Annual Report, 2010*

User Participation (Social Response)

In order to have equitable distribution of water, Water Users' Associations (WUAs) were formed and subsidy has been given to the Water Users' Associations for proper up-keep of infrastructure made under command area development programme. Majority of the states have constituted Water Users' Associations and the number of WUAs is mentioned in table 16. So far, 56838 Water Users' Associations have been constituted in 24 states. And, they cover almost 13 million hectares of land in total. National average WUAs per unit of area comes to be 4. Assam, Haryana, Himachal Pradesh, Kerala and Orissa have a strong network of WUAs. Punjab has 8 WUAs against the national average of 4. More than the number, it is the effective working of these associations which matters. Preliminary information about this aspect is indicative of the fact that free availability of electricity and free canal water in the state has proved to be detrimental to austerity, water use efficiency and social response for better working. It is now that the users have started feeling that it is the reliability and regularity of the system that is needed and not the freeships.

Table 16: State-wise No. of Water User Associations formed and area covered

Sr.	State	No. of WUA formed	Area covered ('000 ha.)	WUA/Area ('000)
1	Andhra Pradesh	10800	4169.00	3
2	Arunachal Pradesh	39	9.02	4
3	Assam	720	47.04	15
4	Bihar	46	147.76	0
5	Chhattisgarh	1324	1244.56	1
6	Goa	57	7.01	8
7	Gujarat	576	96.68	6
8	Haryana	2800	200.00	14
9	Himachal Pradesh	876	35.00	25
10	Jammu & Kashmir	1	1.00	1
11	Jharkhand	NA	NA	-
12	Karnataka	2524	1559.68	2
13	Kerala	4126	255.27	16
14	Madhya Pradesh	1687	1691.88	1
15	Maharashtra	1539	667.00	2
16	Manipur	73	49.27	1
17	Meghalaya	123	16.45	7
18	Mizoram	NA	NA	-
19	Nagaland	23	3.15	7
20	Orissa	16196	1537.00	11
21	Punjab	957	116.95	8
22	Rajasthan	506	619.65	1
23	Sikkim	NA	NA	-
24	Tamil Nadu	1566	787.96	2
25	Tripura	NA	NA	-
26	Uttar Pradesh	279	121.21	2
27	Uttaranchal	NA	NA	-
28	West Bengal	10000	37.00	270
	Total	56838	13419.54	4

Source: Source: CWC, *Financial Aspects of Irrigation Projects in India, 2010*

International Assistance and Cooperation

External assistance flows to the country in various forms; as multilateral or bilateral aid, loan, grants and commodity aid from various foreign countries and other donor agencies. The main source of external assistance in irrigation sector has been the International Bank of Reconstruction and Development (IBRD) commonly known as the World Bank and its soft lending affiliate, the International Development Association (IDA). In addition to the World Bank, other funding agencies such as Japan Bank of International Cooperation (JBIC) and Asian Development Bank (ADB) have also been providing assistance for implementation of irrigation projects.

The World Bank continues to be the primary source of external assistance in the water resources sector. The World Bank assistance is in the form of credit or loan. The World Bank financing policies for irrigation projects change from time to time. Initially it financed individual irrigation projects and then changed to financing composite projects in which a group of major, medium and minor irrigation projects

were financed under a single credit/loan agreement. It then started financing water resources consolidation projects in which irrigation sector of the whole State was involved under one credit/loan agreement. Now the policy of World Bank has shifted to finance water sector restructuring projects in which the emphasis is on irrigation sector reforms of the whole State. Punjab has utilized the World Bank assistance of $290.06 (out of $5217.33 received for 38 projects in the country) to complete two projects (P78, CWC Annual Report, 2009-10).

The three major river systems of India namely Ganga, Brahmaputra and Indus cross international borders. The Ministry of Water Resources is responsible for strengthening international cooperation on matters relating to these rivers by way of negotiations with neighbouring countries in regard to river waters, water resources development projects and operation of international treaties relating to water. Box 4 gives the synoptic view of international cooperation with Pakistan in this regard.

Box 4: Cooperation between India and Pakistan

1. Under the Indus Waters Treaty 1960, India and Pakistan have created permanent posts of Commissioners for Indus Waters, one each in India and Pakistan. Each Commissioner is representative of his Government for all matters arising out of the Treaty and serves as the regular channel of communication on all matters relating to implementation of the Treaty. The two Commissioners together form the Permanent Indus Commission.
2. In fulfillment of the requirements of Indus Water Treaty, the daily data of 280 hydrological sites on six basins, The Indus, The Jhelum, The Chenab, The Ravi, The Beas and The Sutlej of Indus system was sent to Pakistan every month.
3. Flood warning communications were made by India to Pakistan for their benefit through priority Telegrams, Telephones and Radio Broadcasts during the period from 1st July to10th October, 2009, for Indus system of rivers.

Economics of the System with Virtual Export of Water

Supply demand analysis and financial analysis shows that a huge capital and operating expenditure has been done on the irrigation system of the State. It is felt that, giving free electricity and water for irrigation has been a bad economics. These subsidies have attracted a massive criticism from some national and international funding agencies. The economics of the system shows something else. Punjab, the Granary State of the country, provided the much needed food security. It consumed subsidies, it mined water ruthlessly; not for itself. It overused water resources to feed the entire nation. The State should be suitably compensated in much the same manner as states with mineral reserves are given royalty on coal and bauxite. There is a point in this argument; Punjab's virtual water exports amount to 20.9 billion cubic meters every year. "Virtual water" refers to the water embedded in commodities. For instance, a kg of basmati rice takes up to 7,500 liters of water to produce. An equivalent amount of water is deemed to be "exported" along with the rice. Food-surplus states are usually water exporters and the food-deficient ones, like Bihar, the importers. Keeping in view the alarming situation of over exploitation of ground water as described above, there is an urgent need to formulate guidelines for release of electricity connection for agriculture pump sets.

III
Comparison with International Models and Best Practices

An ideal international model of irrigation being debated worldwide is a "public, private and people participation model". It is a model charcterised by reduction in irrigation subsidies that are extended to farmers in developing countries

and ensuring that the farmers pay for the full financial costs. It is a model targeted to promote water user associations so as to empower users to operate and maintain their systems, collect fees, hire professionals and manage water rights. In this model, public sector agencies are supposed to provide the institutional set up that will aid the functioning of the water users associations. At water management level, the parameterization of a self sustaining and surplus generating model is being advocated. This refers to rehabilitation of existing projects in terms of modifying the distribution network and more intensive operation and maintenance of this infrastructure. In the range of best practices, there are several models at the level of design and implementation in their regional and temporal specificity. In India, the State of Andhra Pradesh is best case to be quoted as far as implementation of reforms programme is concerned.

All the models and practices have an inbuilt pre-supposition that the agriculture is a (or should be) commercial sector. Punjab agriculture is far away from these models; it is sector with rigor of national socialist approach of the past. In case of India, since independence, the food security of the nation and floods in the state had been the matter of concern. Canal Irrigation of the region was developed for this purpose. The region was given a package of freebees, knowledge, technology and other inputs to launch a Green Revolution. Hence agriculture development of the region has a social angle than the commercial one. In its effort to provide food grains to the country, the State has mined it's only natural resource ruthlessly. It has been subsidized not for itself but for saving the whole nation from poverty and hunger. If public, privatization and people model with pre-requisite of abolishing subsidies and putting user charges to cover all costs is followed; it will affect the food security adversely. For irrigation related cost recovery, Punjab should be treated a virtual exporter of its only natural resource, the water. Importing States should pay the royalty that can be used to meet the costs of irrigation. Hence, any reforms programme for irrigation in Punjab must be evaluated in its totality, because it is a unique model in itself.

IV
Conclusions and Policy Recommendations

Analysis is indicative of the fact that, in its attempt to provide the much needed food security to the country, Punjab has mined the surface and groundwater ruthlessly which has far reaching consequences for the ecology and environment of the region. In this context, following are the conclusions and policy implications.

Conclusions

1. Punjab, over a period of time has excelled to become the food granary of the country. It provided the much needed food security to the country. High yielding cash crops and expansion of economic activities has led to increasing demand of water for diverse purposes, causing a great stress on available water resources in the State. Agriculture in Punjab is primarily an artificial irrigation based, i.e., using surface as well as ground water resources. Intensive agriculture, based on wheat-rice rotation, has led to a serious imbalance in use and availability of ground resources.
2. The total water supply of 3.13 m ham falls short by 1.27 m ham of the total water demand of 4.40 m ham. The deficit is met by over-exploitation of groundwater reserves through tube-wells and wells.

3. The free electricity along with convenience of use has led to ever before pressure on groundwater. In the absence of any systematic policy to regulate the demand for water, the unconstrained mining of this resource has resulted in over exploitation of groundwater. Presently, the number of "over exploited" blocks has gone to 75.18 percent. Thus, over exploitation of groundwater and reduced share of canal water is drastically depleting the only resource of the Punjab economy. On the whole, the area underlain by groundwater of unfit quality is around 7957 square kilometers which comes out to be 16 percent of Punjab State.

4. In respect of groundwater, the state is facing a dual phenomenon of rising and falling water table. The water table, mostly in South-Western parts, is rising because water extraction is limited due to blackish/saline quality. The water table is falling in North-Western, Central, Southern and South-Eastern parts of the State, where ground water is generally fresh and fit for irrigation. This has far reaching implication for the ecology of the region.

5. Water logging and soil salinity is also the byproduct of irrigation system in the State. While groundwater is declining alarmingly in fresh water regions, it has risen steadily in saline groundwater regions in Muktsar, Bhatinda and Faridkot districts. The original cotton/*bajra*/maize–wheat/gram system has been replaced by rice-wheat rotation resulting from leveling of extensive sand dunes and conversion to irrigated fields. The area under cotton has been affected by the rising water table and farmers are not keen to grow cotton.

6. The scope to address the supply side of water is limited and the major scope lies in managing the demand side of water. The state has gone from growing a previously healthy mix of crops such as wheat, maize, pulses and vegetables to devoting nearly 80 percent of its crop area to rice and wheat, two of the most water-intensive crops. The rice crop has been the most water intensive crop, using about 24000 cubic meters of water per hectare, which is about six times of maize, almost 20 times of groundnut and about 10 times of pulses. This calls for changing the crop mix to save water resources of the State.

7. Irrigation projects of the state are in a complete state of neglect. Poor recovery of working expenses leaves hardly any resources for the upkeep and maintenance of the system. Major reason is the poor resource mobilization and the inability of State to generate the matching grants for the central assistance. Supply, demand analysis and financial analysis at surface level shows that huge capital and operating expenditure has been done on the irrigation system of the State and giving free electricity and water for irrigation has been a bad economics.

8. These subsidies have attracted a massive criticism from some national and international funding agencies. The economics of the system shows something else. Punjab consumed subsidies and it mined water ruthlessly not for itself; but for the entire nation. The State should be suitably compensated much in the same manner as states with mineral reserves are given royalty on coal and bauxite**.** Punjab's virtual water exports amount to 20.9 billion cubic meters every year.

Policy Recommendations

Recently the State has come up with a policy initiative, 'Punjab State Water Policy (2008)', but yet a lot needs to be done. Following are the policy implications of above analysis.

1. To relieve stress on ground water, a greater emphasis is needed on efficient conveyance and distribution system for optimal utilization of available surface water. Punjab needs to be given greater share in its river waters to reduce stress on ground water resources and power consumption.
2. The canal network, which is more than 150 years old, is unable to take its full discharge, as it requires major rehabilitation and rejuvenation. The revenue realization from water charges proved inadequate has been meager and much less than even the recurring O & M charges; consequently having adverse impact on ensuring satisfactory and adequate maintenance. Punjab needs to be compensated with a special package to renovate, extend and upgrade its irrigation system.
3. Reforms must be initiated and implemented in three major areas of canal irrigation system of Punjab: (a) rebuilding and refurbishment of canal system; (b) irrigation water management; and (c) irrigation policy initiatives. Canal irrigation policy and institutional reforms of Punjab must be targeted to regain lost credibility and build the trust. In this regard, *firstly,* the irrigation water should be converted into an economic good by introducing volumetric pricing. Instead of free water and electricity, virtual water importing states should compensate Punjab with a royalty. *Secondly,* the participation of stakeholders and transfer of powers and responsibilities to locals would help in addressing problems. *Thirdly,* at present, the local bodies are bypassed in irrigation matters therefore there is an urgent need to involve *panchayati raj* institutions in this process. *Fourthly,* in whole of the institutional reforms process, the ecological concerns must be taken into consideration. *Finally,* the distributional aspects should be looked upon essentially in terms of equal rights on water for all the stakeholders in the community. The policy framework needs to go much beyond the canal irrigation. It must consider total irrigation as a system that must include groundwater resources, rationing the new tube-well electricity connections, electricity pricing, crop-diversification, diesel pricing and other ecological issues.
4. To minimize the water logging, drainage systems needs to be developed. There is a need to implement projects on integrated farming systems for management of waterlogged saline groundwater regions involving ponds in combination with fisheries, horticultural and agro-forestry trees (bio-drainage). Salt resistant crop/tree varieties should be developed for the waterlogged saline groundwater areas of Punjab.
5. There is an urgent need of the time to change the cropping mix of the State to save the precious water resources. This is high time to reduce the area under paddy and introduction of alternative crops particularly in the Malwa region, to restore the water balance in the long run. The alternative crops (like groundnut, maize, pulses: arhar and moong) have to made competitive with paddy. In addition to water saving, the society will benefit in terms of improvement/ decline in soil degradation of fertility in the long run,

improvement in sanitation and health, improvement in environment and power saving.

To sum up, we can say that the Punjab model of irrigation, has deteriorated the ecology of the region, in general, and the water resources in particular. The repercussions have started to show up in the form of depleted ground water, wide spread salinity, deteriorating water quality and specific kind of disease patterns. Clearly, over the years, a number of issues and challenges have emerged in the development and management of the water resources. All these concerns need to be addressed on the basis of common policies and strategies with a vision of a new considered approach by adopting emerging research in science and technology.

Glossary

ERM: Embankment Renovation and Modernization

Culturable Area: The culturable command area is the geographical area which can be irrigated from irrigation system and is fit for cultivation.

Major Irrigation Project: A scheme having culturable command area more than 10,000 hectares is major irrigation scheme.

Medium Irrigation Project: A scheme having culturable command area more than 2,00 and up to 10,000 hectares individually is medium irrigation scheme.

Major Irrigation Project: A scheme having culturable command area more than 2,000 hectares is minor irrigation scheme.

Command Area Development Programme: Development of geographical area under the command of river valley projects through centrally sponsored or central sector scheme implemented by the State/Central Government for constructing field channels, drainage, system and land leveling of undulating land of farmers. Reclamation of alkalinity and salinity of land are also carried out through Command Area Development Programme.

References

Alam, U. (2002), "Questioning the Water Wars rational: A Case Study of the Indus Waters Treaty", *The Geographical Journal*, **168** (4), pp. 354-64.

Bandaragoda, D.J. (1998): Design and Practice of Water Allocation Rules: Lessons from Warabandi in Pakistan's Punjab, *Research Report 17*, IIMI, May.

Bhangoo, K.S. (2006): "Farmers' Suicides in Punjab: A Study of Bathinda District" *Journal of Agriculture Development and Policy, Vol. XVIII (1&2).*

Biswas, A. (1992), "Indus Water Treaty: The Negotiating Process", *Water International*, **17,** (44), pp. 201- 209.

Bromley, Daniel W., Taylor, Donald C. and Parker, Donald E.(1980), **"**Water Reform and Economic Development: Institutional Aspects of Water Management in the Developing Countries", *Economic Development and Cultural Change*, Vol. 28, (2), pp. 365-387.

Central Water Commission, GOI (2010), *Pricing of Water in Public System in India,* New Delhi, Nov.

Central Water Commission, GOI, (2010), *Financial Aspects of Irrigation Projects in India,* New Delhi.

Central Water Commission, GOI (2010), *Annual Report 2009-10,* New Delhi,

Central Water Commission, GOI, (2011), Online Database: http://www.india-wris.nrsc.gov.in/

Chowdhury, Shyamal and Torero, Maximo, (2007), "Power and Irrigation Subsidies in Andhra Pradesh and Punjab", International Food Policy Research Institute, Washington, D.C.

Dhawan, B.D. (1997), "Large Scale Irrigation: How Cost Effective", *Economic and Political Weekly*, June, pp A 71-77.

Gill, Karam Singh (2003), *Punjab Agricultural Policy Review*, Report for the World Bank, New Delhi.

Gustafson, W. Eric and Reidinger, Richard B. (1971): Delivery of Canal Water in North India and West Pakistan, *Economic and Political Weekly*, Vol. 6 (52), pp A157-A162, Dec.

Hunt, Robert C. (1988), "Size and the Structure of Authority in Canal Irrigations Systems", *Journal of Anthropological Research*, Vol. 44, (4), pp. 335-355.

Hunt, Robert C. and Hunt, Eva (1976), "Canal Irrigation and Local Social Organization", *Current Anthropology*, Vol. 17, (3), pp. 389-411.

Iyer, Ramaswamy R. (2004), "Punjab Water Imbroglio- Background, Implications and the Way Out", *Economic and Political Weekly*, Vol. 39(31), Jul 31-Aug 6, pp 3435-3438.

Jain, A.K. and Kumar, Raj (2007): "Water Management Issues-Punjab, North-West India", Indo-US Workshop, Efficient Water Management, March 5-7, Hyderabad.

Jairath, Jasveen (1985): "Technical and Institutional Factors in Utilization of irrigation-A Case Study of Canals in Punjab", *Economic and Political Weekly*, March.

Kamra, S.K. (2007), "Water logging and Soil Salinity Problems in South West Punjab", Working Paper, Central Soil Salinity Research Institute, Karnal, INDIA, www.cssri.org/kamra.pdf

Khurana, Indira (2006), "Trans-boundary Disputes: Politics and Litigation Play Havoc, Sutlej Yamuna Link Canal", *Economic and Political Weekly*, Feb 18, pp 608-11.

Kurian, Mathew (2004): "Institutional Analysis of Integrated Water Resources Management", in *River Basins*, International Water Management Institute, Working Paper 79, Bangkok.

Madhav Roopa (2007), "Irrigation Reforms in Andhra Pradesh - Whither the Trajectory of Legal Changes**?"** International Environmental Law Research Centre, Working Paper 04.

Ministry of Water Resources, GOI (2002), *National Water Policy Statement*, 2002

Mitra, Ashok K. (1992), "Joint Management of Irrigation Systems in India: Relevance of Japanese Experience", *Economic and Political Weekly*, Vol. 27 (26) pp A75-A82.

Postel, Sandra (1999), *Pillar of Sand: Can the Irrigation Miracle Last?*, New York & London: WW Norton & Company.

Reddy, V. Ratna (2003), "Irrigation Development and Reforms", *Economic and Political Weekly*, Vol. 38 (12 & 13).

Shah, Tushaar, Giordano Mark, and Wang Jinxia (2004), "Irrigation Institutions in a Dynamic Economy: What Is China Doing Differently from India?", *Economic and Political Weekly*, Vol. 39, (31) , pp. 3452-3461.

Singh, Inderjeet and Singh, Lakhwinder (2011), "Regional Input Output Table for the State of Punjab", Working Paper, Online at http://mpra.ub.uni-muenchen.de/32344/, MPRA Paper, No. 32344

Singh Karam (2007): *Punjab, the Dance of Water Table*, The Punjab Farmers Commission, Govt. of Punjab, p 13.

Singh, Karam and Jain, K.K. (2002), *Dynamics of Structural Shifts in Cost and Returns in Farm Economy in Punjab*, Report for ACCP, Agro Economic Research Centre, PAU, Ludhiana, Mar.

Thakkar, Himanshu (1999), "South Asia Network on Dams, Rivers and People, India", Prepared for: *Thematic Review IV.2: Assessment of Irrigation Options*, working paper of the World Commission on Dams, see http://www.dams.org/

Vaidyanathan A (1992), *Report of the Committee on Pricing of Irrigation Water*, Planning Commission, Government of India, New Delhi.

Wittfogel, K. (1957), *Oriental Despotism*, New Haven, Yale University Press, Cornell, USA.